RD-28,965-5 is a
Continuation of RD-28,965-1

CLAIMS:

1. An article, said article comprising:

a) a substrate; and

b) at least one barrier layer disposed on at least one surface of said substrate, wherein said barrier layer comprises an inorganic material, and wherein said barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

2. The article according to Claim 1, further including at least one layer, wherein said at least one layer is disposed adjacent to said barrier layer.

3. The article according to Claim 2, wherein said at least one barrier layer is interposed between said at least one layer and said substrate.

4. The article according to Claim 2, wherein said at least one layer is interposed between said at least one barrier layer and said substrate.

5. The article according to Claim 4, wherein said at least one layer comprises an adhesion layer for promoting adhesion of said at least one barrier layer to said substrate.

6. The article according to Claim 5, wherein said adhesion layer comprises at least one of: a metal in elemental form, a carbide of said metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, and platinum; amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; a polymer; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

7. The article according to Claim 2, wherein said at least one layer comprises at least one of an abrasion resistant layer, an ultraviolet radiation-absorbing layer, an infrared radiation-reflecting layer, and an electrically conducting layer.

8. The article according to Claim 7, wherein said abrasion resistant layer comprises at least one of: a carbide of a metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, and platinum; amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; polymerized monomers; polymerized oligomers; an organic polymer; an inorganic-organic polymer; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

9. The article according to Claim 7, wherein said ultraviolet radiation-absorbing layer comprises at least one of titanium oxide, zinc oxide, cerium oxide, a polymer, and combinations thereof.

10. The article according to Claim 7, wherein said infrared radiation-reflecting layer comprises at least one of silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

11. The article according to Claim 7, wherein said electrically conducting layer comprises at least one of silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

12. The article according to Claim 1, wherein said inorganic material comprises at least one of an oxide, a nitride, and a carbide of a metal, and combinations thereof.

13. The article according to Claim 12, wherein said metal is one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof.

14. The article according to Claim 13, wherein said transition metal is titanium.

15. The article according to Claim 13, wherein said inorganic material comprises titanium oxide.

16. The article according to Claim 13, wherein said inorganic material comprises silicon nitride.

17. The article according to Claim 1, wherein said barrier layer has a thickness in a range from about 10 nm to about 10,000 nm.

18. The article according to Claim 17, wherein said barrier layer has a thickness in a range from about 20 nm to about 500 nm.

19. The article according to Claim 1, wherein said barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

20. The article according to Claim 1, wherein said barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

21. The article according to Claim 1, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

22. The article according to Claim 1, wherein said barrier layer is deposited on said substrate by: injecting at least one reagent into an expanding thermal plasma; reacting said at least one reagent in said expanding thermal plasma to form at least one deposition precursor; and depositing said at least one deposition precursor on said substrate at a rate of at least about 200 nm/min to form said barrier layer on said substrate.

23. The article according to Claim 1, wherein said substrate comprises one of glass, a polymeric material, silicon, a metallic web, and fiberglass.

24. The article according to Claim 23, wherein said polymeric material comprises one of a polycarbonate, a polyethylene terephtalene, a polyethylene naphthalene, a polyimide, a polyethersulfone, a polyacrylate, a polynorbornene, and combinations thereof.

25. The article according to Claim 23, wherein said metallic web comprises one of aluminum and steel.

26. A barrier layer deposited on a substrate, said barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, and wherein each of said metal nitride, said metal carbide, and said metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein said barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

27. The barrier layer according to Claim 26, wherein said transition metal is titanium.

28. The barrier layer according to Claim 26, wherein said barrier layer comprises titanium oxide.

29. The barrier layer according to Claim 26, wherein said barrier layer comprises silicon nitride.

30. The barrier layer according to Claim 26, wherein said barrier layer has a thickness in a range from about 10 nm to about 10,000 nm.

31. The barrier layer according to Claim 30, wherein said barrier layer has a thickness in a range from about 20 nm to about 500 nm.

32. The barrier layer according to Claim 26, wherein said barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

33. The barrier layer according to Claim 26, wherein said barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

34. The barrier layer according to Claim 26, wherein said barrier layer is deposited on said substrate by: injecting a first reagent into an expanding thermal plasma, said first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof; injecting a second reagent into said expanding thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, hydrogen, water, and ammonia; reacting said first reagent and said second reagent in said expanding thermal plasma to form at least one deposition precursor; and depositing said at least one deposition precursor on said substrate at a rate of at least about 200 nm/min to form said barrier layer on said substrate.

35. The barrier layer according to Claim 34, wherein the at least one deposition precursor is deposited at a rate of at least about 600 nm/min to form the barrier layer on said substrate.

36. The barrier layer according to Claim 34, wherein the at least one deposition precursor is deposited on said substrate at a rate of at least about 3,000 nm/min to form the barrier layer on said substrate.

37. An article, said article comprising:

a) a substrate; and

b) at least one barrier layer, said at least one barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of said metal nitride, said metal carbide, and said metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein said barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and

an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

38. The article according to Claim 37, further including at least one layer, wherein said at least one layer is disposed adjacent to said barrier layer.

39. The article according to Claim 38, wherein said at least one barrier layer is interposed between said at least one layer and said substrate.

40. The article according to Claim 38, wherein said at least one layer is interposed between said at least one barrier layer and said substrate.

41. The article according to Claim 40, wherein said at least one layer comprises an adhesion layer for promoting adhesion of said at least one barrier layer to said substrate.

42. The article according to Claim 41, wherein said adhesion layer comprises at least one of: a metal in elemental form, a carbide of said metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, and platinum; amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; a polymer; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

43. The article according to Claim 38, wherein said at least one layer comprises at least one of an abrasion resistant layer, an ultraviolet radiation-absorbing layer, infrared radiation-reflecting layer, and an electrically conducting layer.

44. The article according to Claim 43, wherein said abrasion resistant layer comprises at least one of: a carbide of a metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, and platinum; amorphous

carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; polymerized monomers; polymerized oligomers; an organic polymer; an inorganic-organic polymer; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

45. The article according to Claim 43, wherein said ultraviolet radiation-absorbing layer comprises at least one of titanium oxide, zinc oxide, cerium oxide, a polymer, and combinations thereof.

46. The article according to Claim 43, wherein said infrared radiation-reflecting layer comprises silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

47. The article according to Claim 43, wherein said electrically conducting layer comprises silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

48. The article according to Claim 37, wherein said transition metal is titanium.

49. The article according to Claim 48, wherein said barrier layer comprises titanium oxide.

50. The article according to Claim 37, wherein said barrier layer comprises silicon nitride.

51. The article according to Claim 37, wherein said barrier layer has a thickness in a range from about 10 nm to about 10,000 nm.

52. The article according to Claim 51, wherein said barrier layer has a thickness in a range from about 20 nm to about 500 nm.

53. The article according to Claim 37, wherein said barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

54. The article according to Claim 37, wherein said barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

55. The article according to Claim 37, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

56. The article according to Claim 37, wherein said barrier layer is deposited on said substrate by: injecting a first reagent into an expanding thermal plasma, said first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof; injecting a second reagent into said expanding thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, and ammonia; reacting said first reagent and said second reagent in said expanding thermal plasma to form at least one deposition precursor; and depositing said at least one deposition precursor on said substrate at a rate of at least about 200 nm/min to form said barrier layer on said substrate.

57. The article according to Claim 37, wherein said substrate comprises one of glass, a polymeric material, silicon, a metallic web, and fiberglass.

58. The article according to Claim 57, wherein said polymeric material comprises one of a polycarbonate, a polyethylene terephtalene, a polyethylene naphthalene, a polyimide, a polyethersulfone, a polyacrylate, a polynorbornene, and combinations thereof.

59. The article of Claim 57, wherein said metallic web comprises one of aluminum and steel.

60. A method of forming a coated article, the coated article comprising a substrate and a barrier layer disposed thereon, wherein the barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and

an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day, the method comprising the steps of:

a) providing a substrate;

b) generating an thermal plasma, the thermal plasma having an electron temperature of less than about 1eV;

c) injecting at least one reagent into the thermal plasma;

d) reacting the at least one reagent in the thermal plasma to form at least one deposition precursor;

e) depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min to form the barrier layer on the substrate.

61. The method of Claim 60, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min to form a barrier layer on the substrate comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min to form a barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof on the substrate.

62. The method of Claim 61, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof.

63. The method of Claim 61, wherein the transition metal is titanium.

64. The method of Claim 60, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

65. The method of Claim 60, wherein the step of providing a substrate comprises providing one of a glass substrate, a polymeric substrate, a silicon substrate, a metallic web substrate, and a fiberglass substrate.

66. The method of Claim 65, wherein the polymeric substrate comprises one of a polycarbonate, a polyethylene terephtalene, a polyethylene naphthalene, a polyimide, a polyethersulfone, a polyacrylate, a polynorbornene, and combinations thereof.

67. The method of Claim 65, wherein the metallic web comprises one of aluminum and steel.

68. The method of Claim 60, wherein the step of generating a thermal plasma comprises generating an expanding thermal plasma.

69. The method of Claim 60, wherein the step of injecting at least one reagent into the thermal plasma comprises injecting a first reagent into the thermal plasma, the first reagent comprising at least one of a silane, a metal vapor, a metal halide, and an organic compound of a metal, wherein the metal is one of titanium, zinc, aluminum, indium, and tin, and combinations thereof.

70. The method of Claim 69, wherein the silane is one of a disilane, an aminosilane, and a chlorosilane.

71. The method of Claim 69, wherein the organic compound is one of titanium isopropoxide, diethyl zinc, dimethyl zinc, indium isopropoxide, indium tert-butoxide, aluminum isopropoxide, and combinations thereof.

72. The method of Claim 69, wherein the metal halide is a metal chloride.

73. The method of Claim 69, further comprising the step of injecting a second reagent into the plasma, the second reagent comprising at least one of oxygen, nitrogen, hydrogen, water, and ammonia.

74. The method of Claim 60, further comprising the step of depositing at least one layer on one of the barrier layer and the substrate.

75. The method of Claim 74, wherein the step of depositing at least one layer on one of the barrier layer and the substrate comprises depositing at least one layer of an organic material on one of the barrier layer and the substrate, the organic material comprising at least one of polymerized monomers, polymerized oligomers, a polymer, an epoxide, an acrylate, an acrylonitrile, a xylene, a styrene; and combinations thereof.

76. The method of Claim 74, wherein the step of depositing at least one layer on one of the barrier layer and the substrate comprises depositing at least one layer of an inorganic material on one of the barrier layer and the substrate, the inorganic material comprising at least one of: a carbide of a metal, an oxycarbide of said metal, an oxide of said metal, a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, and platinum; amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride.

77. The method of Claim 74, wherein the step of depositing at least one layer on one of the barrier layer and the substrate comprises depositing at least one layer of an hybrid organic-inorganic material on one of the barrier layer and the substrate, the hybrid organic-inorganic material comprising at least one of a silicone, a siloxane, and an organic-inorganic polymer.

78. The method of Claim 60, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min to form the barrier layer on the substrate comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 600 nm/min to form the barrier layer on the substrate.

79. The method of Claim 78, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 600 nm/min to form the barrier layer on the substrate comprises depositing the at least one deposition

precursor on the substrate at a rate of at least about 3,000 nm/min to form the barrier layer on the substrate.

80. The method of Claim 60, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 3,000 nm/min to form the barrier layer on the substrate comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 10,000 nm/min to form the barrier layer on the substrate.

81. A method of forming a barrier layer on a substrate, wherein the barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day, and wherein the barrier layer comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, the method comprising the steps of:

a) generating a thermal plasma, the thermal plasma having an electron temperature of less than about 1eV;

b) injecting a first reagent into the thermal plasma, the first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof;

c) injecting a second reagent into the thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, and ammonia;

d) reacting the first reagent and the second reagent in the thermal plasma to form at least one deposition precursor; and

e) depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min, thereby forming the barrier layer comprising at

least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof on the substrate.

82. The method according to Claim 81, wherein the step of generating a thermal plasma comprises generating an expanding thermal plasma.

83. The method according to Claim 81, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 600 nm/min.

84. The method according to Claim 83, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 600 nm/min comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 3,000 nm/min.

85. The method according to Claim 84, wherein the step of depositing the at least one deposition precursor at a rate of at least about 3,000 nm/min to form the barrier layer on the substrate comprises depositing the at least one deposition precursor at a rate of at least about 10,000 nm/ min on the substrate.

86. A method of forming a coated article, the coated article comprising a substrate and a barrier layer disposed thereon, wherein the barrier layer has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day, and wherein the barrier layer comprises at least one of at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, the method comprising the steps of:

a) providing a substrate;

b) generating a thermal plasma, the thermal plasma having an electron temperature of less than about 1eV;

c) injecting a first reagent into the thermal plasma, the first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof;

d) injecting a second reagent into the thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, water, and ammonia;

e) reacting the first reagent and the second reagent in the thermal plasma to form at least one deposition precursor; and

f) depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min, thereby forming the barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof on the substrate.

87. The method of Claim 86, wherein the transition metal is titanium.

88. The method of Claim 86, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, and an organic electroluminescent device (OELD).

89. The method of Claim 86, wherein the step of providing a substrate comprises providing one of a glass substrate, a polymeric substrate, a silicon substrate, a metallic web substrate, and a fiberglass substrate.

90. The method of Claim 86, wherein the polymeric substrate comprises one of a polycarbonate, a polyethylene terephtalene, a polyethylene naphthalene, a polyimide, a polyethersulfone, a polyacrylate, a polynorbornene, and combinations thereof.

91. The method of Claim 86, wherein the metallic web comprises one of aluminum and steel.

92. The method of Claim 86, wherein the step of generating a thermal plasma comprises generating an expanding thermal plasma.

93. The method of Claim 86, wherein the step of injecting at least one reagent into the thermal plasma comprises injecting a first reagent into the thermal plasma, the first reagent comprising at least one of a silane, a metal vapor, a metal halide, and an organic compound of a metal, wherein the metal is one of titanium, zinc, aluminum, indium, tin, and combinations thereof.

94. The method of Claim 93, wherein the silane is one of a disilane, an aminosilane, and a chlorosilane.

95. The method of Claim 93, wherein the organic compound one of titanium isopropoxide, diethyl zinc, dimethyl zinc, indium isopropoxide, indium tert-butoxide, aluminum isopropoxide, and combinations thereof.

96. The method of Claim 93, wherein the metal halide is a metal chloride.

97. The method of Claim 86, wherein the second reagent comprises at least one of oxygen, nitrogen, hydrogen, water, and ammonia.

98. The method of Claim 86, further comprising the step of depositing at least one layer on one of the barrier layer and the substrate.

99. The method of Claim 86, wherein the step of depositing at least one layer on one of the barrier layer and the substrate comprises depositing at least one layer of an organic material on one of the barrier layer and the substrate, the organic material comprising at least one of polymerized monomers, polymerized oligomers, a polymer, an epoxide, an acrylate, an acrylonitrile, a xylene, a styrene, and combinations thereof.

100. The method of Claim 86, wherein the step of depositing at least one layer on one of the barrier layer and the substrate comprises depositing at least one layer of an inorganic material on one of the barrier layer and the substrate, the inorganic material comprising at least one of: a carbide of a metal, an oxycarbide of the metal, an oxide of the metal, and a nitride of the metal, wherein the metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, and platinum;

amorphous carbon; a ceramic material, wherein the ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride.

101. The method of Claim 86, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min comprises depositing the at least deposition precursor on the substrate at a rate of at least about 600 nm/min.

102. The method of Claim 101, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 600 nm/min comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 3,000 nm/min.

103. The method of Claim 102, wherein the step of depositing the at least one deposition precursor on the substrate at a rate of at least about 3,000 nm/min comprises depositing the at least one deposition precursor on the substrate at a rate of at least about 10,000 nm/min.